

CLAIMS

What is claimed is:

- 1 1. An apparatus comprising:
2 a plasma chamber containing a plasma for a plasma-assisted material
3 process upon a substrate;
4 a shielding plate within said plasma chamber to actively direct ion
5 flux to desired areas of the substrate; and
6 a supporting structure to support said shielding plate within said
7 chamber.
- 8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
- 1 2. The apparatus of claim 1 wherein the plasma-assisted material process is a
2 plasma-assisted etching process.
- 3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
- 1 3. The apparatus of claim 1 wherein the plasma-assisted material process is a
2 plasma-enhanced chemical vapor deposition process.
- 3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
- 1 4. The apparatus of claim 1 wherein the shielding plate and the supporting
2 structure are composed of a dielectric material.
- 3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
- 1 5. The apparatus of claim 1 wherein the supporting structure further comprises
2 three or more supporting members.
- 3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100

2 6. The apparatus of claim 1 wherein the shielding plate is solid to suppress ion
3 flux at the center of the substrate.

1

2 7. The apparatus of claim 1 wherein the shielding plate has one or more
3 perforations that allow ion flux to pass, such that the ion flux within a localized area
4 of the substrate is fitted to meet the requirements of a desired material process.

1

2 8. The apparatus of claim 1 wherein the dimensions of the plate are dependent
3 upon the dimensions of the plasma chamber and the substrate.

1

2 9. The apparatus of claim 8 wherein the thickness of the plate is 2-5 mm.

1

2 10. The apparatus of claim 1 wherein the distance between a member of said
3 supporting structure and said substrate is greater than the mean free path of a
4 reactive particle.

1

2 11. The apparatus of claim 1 wherein the width of a member of said supporting
3 plate is less than the mean free path of a reactive particle.

1

2 12. The apparatus of claim 1 wherein the edge of said plate is rounded.

1

2 13. The apparatus of claim 1 wherein the plate is circular.

1

2 14. The apparatus of claim 1 wherein the plasma-assisted material process is
3 carried out in high-density plasma.

1

2 15. A method comprising:

3 optimizing the dimensions, geometry, and location of a shielding
4 plate to generate a desired ion flux in a plasma-assisted material process
5 conducted in a plasma chamber;

6 inserting the plate above a substrate in the chamber; and

7 carrying out the desired material process upon the substrate by the
8 ion flux generated.

1

2 16. The method of claim 15 further comprising optimizing the dimensions,
3 geometry, and location of the shielding plate by numerical simulation.

1

2 17. The method of claim 16 further comprising performing the optimization
3 process such that a set of numerically simulated plasma potential contour lines are as
4 close to parallel to the plane of a simulated substrate surface as possible.

1

2 18. The method of claim 15 further comprising varying localized ion flux across
3 said substrate by perforating said plate.

1

2 19. The method of claim 14 further comprising optimizing the uniformity of
3 energy flux across the substrate surface.

1

2 20. A method comprising:
3 actively directing ion flux within a plasma chamber by the insertion
4 of a plate into the chamber; and
5 regulating ion flux to different areas of the substrate by altering
6 properties of the plate.

1

2 21. The method of claim 20 further comprising conducting a plasma-assisted
3 etching process upon the substrate.

1

2 22. The method of claim 20 further comprising conducting a plasma-enhanced
3 chemical vapor deposition process upon the substrate.

1

2 23. A method comprising:
3 placing a shielding plate within a plasma chamber to actively direct
4 ion flux, such that the ratio of (neutrons) / (neutrons + ions) bombarding a
5 substrate is regulated.

1

2 24. The method of claim 23 further comprising controlling the rates of horizontal
3 and vertical etching upon the substrate.

1

2 25. The method of claim 24 further comprising producing cavities in the
3 substrate having the desired critical dimensions by the directed ion flux.

1

2 26. The method of claim 25 further comprising customizing the dimensions of
3 each cavity according to the requirements of a plasma-assisted etching process.

1

2 27. A method comprising:

3 actively directing ion flux within a plasma chamber by the insertion
4 of a shielding plate such that the accumulation of etching by-products across
the surface of a substrate is regulated.

2 28. The method of claim 27 further comprising improving etch uniformity across
3 the substrate.

1

2 29. The method of claim 27 further comprising:

3 preventing the non-uniform accumulation of etching by-products at
4 the center of a substrate; and
5 increasing the etching rate at the center of the substrate.